DOCUMENT RESUME

ED 286 436 HE 020 714

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TITLE The Disciplines and Undergraduate Lecturing.
PUB DATE Apr 87
NOTE 57p.; Paper presented at the Annual Meeting of the American Educational Research Association (Washington, DC, April 20-24, 1987).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Biological Sciences; *College Instruction; *College Science; Comparative Analysis; Higher Education; *Humanities; *Intellectual Disciplines; *Lecture Method; Physical Sciences; *Social Sciences; Undergraduate Study

ABSTRACT

Characteristics of disciplines that affect undergraduate lecturing and teaching approaches were studied in the fields of the physical sciences, life sciences, humanities, and social sciences. A 1981 questionnaire on the lecture method of instruction was completed by a random sample of 820 teachers in the undergraduate liberal arts divisions of U.S. universities. A subsample of 81 teachers provided open-ended interviews. In teaching undergraduate classroom course sessions, 80% of the 820 had lectured throughout all or most of the class period. The available original disciplinary knowledge about course topics was voluminous, complexly articulated, and advanced in nature. Instructors needed to make a stringent selection from the oversupply of raw materials, needed to create teachable organizations of disciplinary topics, and needed to make the material understandable. For the physical and life sciences, lecturing worked best, while in literature, discussion techniques were favored, and in social sciences a mixed mode was used. Also assessed was the role of class size and teachers' early predispositions as factors mediating the impact of disciplinary attributes on the classroom. (SW)

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(Abstract)

The Disciplines and Undergraduate Lecturing

A 1981 questionnaire on the lecture method of instruction was completed by a random sample of 820 teachers in the undergraduate liberal arts divisions of American universities. A sub-sample of 81 teachers provided open-ended interviews. In teaching undergraduate classroom course sessions, 80% of the 820 had lectured throughout all or most of the class period.

The paper explores how key characteristics of disciplines' bodies of knowledge shape the way instructors fashion college-level versions of disciplinary topics. In each of the four fields studied -- the physical sciences, life sciences, humanities, and social sciences -- the available original disciplinary knowledge about course topics is characteristically so voluminous, so complexly articulated, and so advanced in nature that instructors need to make a stringent selection from the oversupply of raw materials, to create teachable organizations of disciplinary topics, and to translate materials down to a level undergraduates can understand. Interview quotes make clear that instructors found lecturing the most effective or most feasible mode of instruction to fulfill each of the three kinds of necessary manipulations.

Other disciplinary attributes influenced teaching more idiosyncratically. Traits distinctive to the physical and life sciences pressed teachers still further towards near-total reliance on lecturing. In literature, other traits endowed student beliefs and viewpoints with substantial validity, leading instructors towards more extensive use of discussion techniques in class. In the social sciences, a mixed set of disciplinary influences induced teachers to adopt an intermediate posture.

The paper also explores the role of class size and teachers' early predispositions as factors mediating the impact of disciplinary attributes on the classroom.

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THE DISCIPLINES AND UNDERGRADUATE LECTURING*

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In a sense, the subject of the research described here is an odd one. It falls at the intersection of two salient phenomena of higher education. Both are widely recognized as central parts of the institutional machinery colleges and universities use to provide education. Yet both remain substantially unexamined by directly focused research. These two neglected phenomena are the undergraduate lecture and the teaching of the academic disciplines. This paper reports the results of a survey and interview study exploring the ways in which the academic disciplines, in the United States, shape instructors' lecturing in undergraduate classrooms.

The ubiquitous lecture.

The word "lecture" has a variety of meanings. We use it here to describe uninterrupted or comparatively uninterrupted talk by a teacher on an academic subject, usually in a classroom setting. A professor who gives an "explanation" or a "talk" in class is, by this standard, lecturing. So too are instructors who read poetry aloud, derive formulas on the blackboard, present demonstrations (unless these involve talk by others), and so on. Other teaching activities, such as "clarifying" a question or "sensitizing" students to a concept, also involve lecturing once they include continuous teacher talk.

In the college classroom, lecturing dominates. Though studies which focus directly on the lecture are rare, a good number of incidental findings exist which show without exception that, in undergraduate classes, far more hours of instruction involve lecturing than involve all other methods of instruction combined. The 1984 Carnegie survey of faculty on American university campuses found that "beginning classes are typically lecture courses, with relatively large numbers of students . . . [and] classes in the upper division of undergraduate years are also largely carried out by lectures" (Clark, in preparation:Ch. 4). Findings which uniformly show lecturing far most prevalent have come from nationwide samples (Educational Testing Service, 1979; Blackburn et al., 1980), regional surveys (Umstattd, 1954), discipline-wide samples (Bradshaw & McPherron, 1978; Lasker, 1963), and surveys of a single campus based on systematic classroom observation (Macke & Richardson, 1980) or on instructor depictions (Evans, 1967; Kozma, 1978). Abroad, a survey among three-quarters of all instructors in England and Scotland found that "at most universities the lecture remains in most subjects the main vehicle for instruction" (Hale, 1964:52). Blackburn et al. (1980:41) summarize these findings well: In almost any college, "give a faculty almost any kind of a class in any subject . . . and they will lecture." Studies which record the extent of alternative kinds of

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*Paper presented at the annual meetings of the American Educational Research Association, Washington, April, 1987.

teaching (e.g., Blackburn et al., 1980) show only the discussion method in any widespread use, with the niches occupied by recitation, Socratic techniques, seminars, etc., proving very small.

The lecture does not prevail because it is beloved. Over the centuries many educators have denounced the lecture "with a personal enthusiasm" (Bane, 1931:39). As a young adult, Socrates told the distinguished Protagoras that he could not learn from lectures, and departed when the unmoved Protagoras continued with a long speech (U. of California-Davis, 1980:19). What Gage (1978:76) terms the traditional argument, that students do not learn as well from lecturing as from other instructional methods, was put trenchantly by Samuel Johnson: He "knew nothing that can be best taught by lecture" (Boswell, 1791:356). President Eliot of Harvard used the occasion of his inaugural to expatiate upon another ancient theme, that students learn only passively from lectures:

> Lectures alone are too often a useless expenditure of force. The lecturer pumps laboriously into sieves. The water may be wholesome; but it runs through. A mind must work to grow. (Eliot, 1869:610).

Since the turn of the century, educators deeply committed to such views have periodically mounted determined campaigns to replace the lecture with better forms of instruction. The new formats have included, successively, the discussion method, independent study, television, programmed instruction, computerized instruction, the student-paced "Keller Method," and other less widely-known innovations. But none has produced any notable improvement, at least in overall outcome: when a particular course is taught in two sections, one using a new method to provide a substantial part of the instruction and the other using lectures, the results prove essentially interchangeable (McKeachie, 1963; Dubin & Taveggia, 1968). True, reviews of the more recent research (e.g., McKeachie, 1970; Kulik & Kulik, 1979) give some of the alternatively-taught courses an edge in particular kinds of gains. But clearly the revolution has yet to come. And the criticism rolls on: "The mass lecture is the ultimate denigration of the human personality (Goodman et al., 1974:197)."

Meanwhile, distinguished voices (e.g., Highet, 1950; Barzun, 1968; Hildebrand, 1980) have spoken in clear support of the lecture. But amid the continuing outcry for improvement, and the occasional rejoinder, no one has sought to explain in more objective fashion the lecture's strong hold on undergraduate instruction. This paper explores a potentially salient factor in this hold, the structuring of undergraduate teaching to suit the nature of academic disciplines.

Nor does the prevalence of lecturing betoken the prestige of teaching or the high standing of teachers. Some educators assign to undergraduate teaching, at least, a place secondary in a university's priorities to its research function. Indeed, a substantial sector of the university faculty awards lower priority to teaching in general. Clark (in preparation: Ch. 4), summarizing a recent Carnegie interview study, concludes that for this sector, teaching "steals time away from something

more basic [i.e. research] and is seen as more of a burden." Some would add that graduate teaching has at least the rewards of training future colleagues, while undergraduate teaching (Light, 1974) is merely an unrewarding chore, a duty undertaken as a service to the university.

For another sector of the faculty, notwithstanding, teaching retains great appeal. The 1984 Carnegie questionnaire found that, even at the nation's most prestigious and most research-minded institutions, some 39% of the faculty expressed greater personal interest in teaching than in research; at the nation's less prestigious universities the figure was 75% (Boyer, 1987:130). At the leading research institutions, again, fully 72% of the faculty were currently engaged in teaching undergraduates. It seems sensible to ask whether academics may not feel a clear professional responsibility to teach their disciplines, and on both graduate and undergraduate levels, as well as to advance them. In this paper's terms, we should stay alert to the possibility that lecturing, which is so central to undergraduate teaching, has real intrinsic rewards for academics which stem at least in part from their work as members of disciplines.

Undergraduate lecturing should also be viewed from a third perspective, one so familiar as to be easily overlooked. At American colleges and universities, and widely elsewhere, education is divided formally into the units we call courses. Characteristically, a course offers instruction from at least two principal kinds of sources. One kind brings teachers and students together in a classroom, most often for teacher lecturing but also for discussions and other instructional arrangements. As a second principal source, most courses also expect extensive outside reading, asking students to learn from a textbook, an anthology, or the like. Too, assignments such as homework problems, weekly reports, or term papers are included to provide additional benefits. Lecturing is at most a major part, but not the whole, of all provided course instruction.

Thus the institutional norm of providing instruction through multiple sources, and of course the fixed scheduling of hours at which classes meet, impose multiple constraints on teachers. They must fit lecturing on disciplinary topics to a standard and a schedule which have no intrinsic connection to the content of those topics.

The available research. The study offered here has not been shaped by any accumulation or tradition of research on the undergraduate lecture. There exist a handful of studies which focus on lecturing (including Bloom, 1953, 1954; Solomon et al., 1963; Bers, 1975; Williams & Ware, 1977; Taylor & Weinberg, 1978; Fisher, 1978; Brown et al., 1984; Terpstra, 1979; Erdle & Murray, 1986), and a considerable number of incidental findings in studies devoted mainly to other matters. These empirical results have been examined elsewhere in some depth (Thielens, 1985) . The few findings germane to the present research will be offered as appropriate in the body of the paper.

The academic disciplines.

The disciplinary context of academics' work, scholars believe (Clark, in preparation; Becher, 1984), permeates that work in all its aspects. Research has delineated penetrating differences in the cognitive structure of the disciplines, in particular of dimensions of that structure that give distinctive shape to the disciplines' research and scholarship (Finkelstein, 1984: 100-101 and passim).

Our goal in this paper is to explore the way disciplinary contexts permeate academics' undergraduate teaching, and especially lecturing. We will examine how both similarities and differences among those contexts find expression in and give characteristic shape to classroom instruction.

The available scholarship and research on the disciplines, though extensive, offer comparatively little assistance towards this goal. A well-developed branch of this literature deals with the physical sciences. Their natural history, the structure of their disciplinary bodies of knowledge, and the patterns of growth and change of their research and scholarship, are each subjects of a rich body of inquiry. Titles which provide entree to the three specialties include, respectively: Zuckerman, 1972, and Merton, 1973; Parsons, 1965, and Clark, in preparation; Bresser, 1985. A focal stress on the academic disciplines has also characterized studies by educators of the college and university curriculum (e.g., Phenix, 1964), accounts by historians of the rise of the medieval university in Europe (e.g., Rashdall, 1895) and of the development of American universities in the 19th century (e.g., Katz, 1972), and studies by sociologists of the social structure of higher education and of its role in society (e.g., Collins, 1979).

A suitable classification. If only because the disciplines are so numerous, studies typically group them into more manageable sets or classes. Quite often these are based on no more than traditional practice. A contemporary undergraduate College of Arts and Sciences, for instance, will commonly divide its offerings among four fields: the humanities, the social sciences, the physical sciences, and the biological sciences. The field of social science, for example, will usually include the disciplines of sociology, political science, anthropology, and others. In this paper a traditional classification of fields, with a necessary modification, will serve well for exploring instructors' undergraduate lecturing.

A more formally grounded classification will also prove useful. In analyzing the nature of scientific revolutions, Kuhn (1970) depicts the interlocking dimensions of "normal science." We can (arbitrarily) apportion these into a set of seven: (1). Those engaged in a discipline or subdiscipline in the physical sciences show high agreement as to what they know about the part of nature their discipline deals with, the rules and equipment for learning about it, a language that describes it, and so on. When competing schools appear, they are limited in scope and dealt with by bringing them

into open engagement. In other disciplines -- a residual category to which Kuhn devotes little attention -- differences among practitioners are endemic, even on such fundamentals as the discipline's proper terrain, fundamental assumptions, and appropriate manner of growth. Rival parties may never directly engage each other, and the discipline instead develops mechanisms to live permanently with the disagreements. (2). Science is esoteric. It defines its subject matter using exotic vocabulary, it demands refined skills of practitioners, and it employs elaborate equipment. The members of a scientific community provide the principal audience for and serve as the main judges of its work. Other disciplines deal with a more everyday subject matter, and often write in ways that are intelligible to a generally-educated audience. (3). The sciences address their subjects with a narrow scope of focus. They each concentrate on a small range of specialized problems, to examine a delimited part of nature in great depth. Other disciplines, presumably, can have wider horizons, but Kuhn does not describe them. (4). The sciences rely extensively on symbolic generalizations -- on theories and other depictions of regularities. They often use powerful techniques of logic and mathematical manipulation to describe their work. (5). Scientific practice is oriented to puzzle-solving. The shared topics, beliefs, and techniques involve shared models which provide important guidance in locating suitable puzzles to work on and making suitable efforts towards their solution. The answers are best formulated when they allow others to predict accurately the new answers they will obtain when they address the same puzzle. (6). The "normal" course of development for a science is unidirectional and irreversible, an accumulation of discoveries using a growing stockpile of scientific equipment and techniques. New knowledge replaces only ignorance, not incompatible knowledge; it is based on evidence, acquired through the appropriate skilled use of appropriate research methods. (7). Scientists' conceptions of truth depict the entities that nature does and does not contain, and describe how those entities behave. Questions about nature have a right answer, and other answers are wrong. Nature is too complex and varied to be explored at random, so scientific research provides information which serves to map specific conformations of nature.

Several other classifications exist (e.g., Snow, 1964; Biglan, 1973), but we need not consider them.

A pattern in multi-disciplinary findings. Published reports of research comparing higher-education disciplines often record only the findings which are statistically significant. Yet accounts which provide more complete results often reveal a pattern, so prosaic that it ordinarily receives little attention. This pattern takes on considerable interest when put next to the similar pattern that appears in the findings this paper will describe. Such reports repeatedly show that when a number of disciplines or fields are compared, they appear to be closely alike in certain regards, and markedly different in others. This partly-similar-partly-divergent profile characterizes all 9 of the studies we located for which the possibility could be checked. It held true for professors'

perceptions: of the importance of various analytical reasoning skills to success in graduate school (Powers and Enright, 1986); of the way a professional school's "professional preparation environment" is shaped by societal supports, the influence of the professional community, institutional support, etc. (Stark et al., 1987); of a college's teaching goals (Gaff and Wilson, 1970; Stark and Morstain, 1978); and of the comparative importance of academics' various campus roles (Kelly and Hart, 1971). It also held true for students' perceptions of the characteristics of a course and its instructor (Astin, 1965; Solomon, 1966), of the personality and mind-set of a typical professor in a given discipline (Lewis, 1967), and of teachers' classroom behavior (Erdle and Murray, 1986).

This pattern alerts us to look for commonalities as well as differences, in our comparisons of academic fields and disciplines, and suggests that we should pay close analytic attention to either, or both, as we find them.

Research methods.

Using a two-stage sampling design, the study first chose a random half, 83, of the 165 American institutions classified as universities by the Carnegie Commission (1973), and obtained catalogs for the undergraduate liberal-arts branch of each. Of the 83 catalogs, 80 listed faculty names by department. From the 80 catalogs we selected a random sample of all persons listed as teaching courses in the physical sciences, life sciences, social sciences, and humanities; this yielded a set of 1,041 names.

In the spring of 1981 a short questionnaire was mailed to the 1,041 individuals. Four follow-up mailings produced a total of 820 usable questionnaires, a 79% return. In addition, 81 of the 820 respondents completed 10- to 45-minute interviews about lecturing.

The study was designed to explore the teaching practice of instructors who hold at least a moderately well-established place on their campus -- as the appearance of their names in a printed catalog presumably betokens. Among this sector of the faculty, we thought likely, would appear many of the academics who influence local teaching practice, by their example or by their power over decisions. Be that as it may, those named in the catalogs did hold substantial campus standing: all but 10 of the 820 were full, associate, or assistant professors.

Numerous contemporaneously-recorded traits of the 80 universities and their undergraduate liberal-arts colleges were obtained from: NCHEMS, 1981; Barron's, 1980; Cass and Birnbaum, 1981; and Peterson's, 1980.

I. THE DISCIPLINES' SHARED ATTRIBUTES

Our results again confirm an oft-recorded finding: In our respondents' classrooms, lecturing proved by far predominant over all other teaching methods combined. Describing the most recent class session they had held in an undergraduate course, 7% of the sample members said they "lectured continuously for most of the period, with no interruptions from students," and a full 73% "lectured for most of the period, pausing now and then for student questions or comments." Thus exactly four-fifths of the total, 80%, lectured through essentially the entire class. An additional 9% said they had lectured for perhaps "15 to 25 minutes," but not during the remainder of the period. The remaining 11% said they had for the most part done "something else."

These figures intimate that when classes are devoted largely to lecturing, most instructors believe students should have an opportunity to speak. But as an economist explained, this norm can all too easily be neglected: "I don't elicit as many questions as I should, because I tend to wind up and don't really pause to ask for them, and the students don't like to interrupt me." A single example should conjure up, for readers to whom it must be familiar, the more common mode of classroom discourse, a lecture punctuated briefly by student talk. A psychology professor

> . . . had been saying that a depressive episode could follow upon a violation of one's own moral code, and had given some examples. A student asked if the same effect could result if the moral failure was committed by a loved one, especially a parent. Two rather striking examples immediately came to mind, and I described them.

Bloom (1953, 1954) found that college teachers underestimate the extent of their lecturing, particularly when they are supposed to be leading a discussion. Our interviews hint that the misperception may still persist. A professor of sociology noted that in his department, "we call almost all the courses 'lecture-discussion'; we welcome questions, and often times will lecture for 15 or 20 minutes and then throw out some questions before continuing." The discussion here, surely, formed a thin part of a lecture-discussion format.

Altogether, we believe, a conservative estimate would allocate some four-fifths of the 820 respondents' declared class time to lecturing. Though most of the 80% who gave lectures for a full period allowed student questions and comments, these pauses seem well offset by the 15-to-25-minute lecture episodes. If professors systematically understate the actual extent of their lecturing, our estimate falls short. Whatever the case, our study deals with teaching as instructors experience and describe it.

None of the 81 interviewed professors described teaching a course in which lectures provided the only instruction. The interviews (and Blackburn et al., 1980) also provide a strong indication that the one-fifth of our sample's classroom teaching not devoted to lecturing went primarily to discussion, and to a scattering of seminars. In the past, as a group, the interview respondents had

tried a substantial variety of innovative or experimental teaching methods. At the time of the interviews, however, none were employing these methods.

When a social phenomenon is as widespread as undergraduate lecturing, the causal forces that create and sustain it are likely to be numerous and broad in gauge. This paper explores only one class of the influences that make lecturing predominant in teaching, those arising from the shaping impact of teachers' disciplines. The academics we studied, like those in the 1984 Carnegie survey (Clark, in preparation), rely heavily on lecturing in a great variety of undergraduate teaching circumstances. We cannot pin down the exact part disciplinary attributes play in this phenomenon. But our search should be for attributes which exert a wide influence.

Three shared attributes.

An English professor summarized his department's views on the lecture:

> There is definitely a feeling that the lecture is the best available way to digest material, select it, order it, arrange it, and present it to students. It often allows the teacher to establish the course's basic material. It is the natural way to work with literature.

This summary encapsulates three key attributes of academic disciplines to which undergraduate instructors find lecturing the best, and sometimes the only, possible teaching response.

First, disciplines contain a vast body of knowledge, ideas, and other work -- or as teachers often put it, of "material." To teach a course dealing with even a small sector of a discipline, or to teach a small part of that sector for an hour, teachers throughout academe must select, from a store of pertinent material much larger than they can offer students, the fraction which is most central. They must choose the best textbook (if there is one), the right viewpoints, the key topics, the telling examples, and so on. We will show that professors find lecturing the best available way to transmit much, but not all, of this selection to students.

Second, teachers in every discipline confront a body of knowledge too amorphous, too unclear, or too complex in the linkages among its parts, for direct transmission to undergraduates. Teachers must devise for the diverse materials they want to teach an appropriate structure. We will show, again, that professors find lecturing the best way to present much, though not all, of their devised structure.

Third, academics find their disciplines' primary materials so advanced and difficult in nature as to require appropriate simplification for undergraduates' comprehension. The best way to simplify well is to lecture on a level attuned to students' capacities and interests.

In practice, instructors preparing a course discover that the disciplinary materials they want to use most often have all three of these characteristics: The course content must be winnowed from a large body of material, the material in its original form is amorphous in contours, and it is too difficult

for the students. For analytical purposes, however, we need to consider each of the three attributes separately, and their relation to lecturing.

Selection.

To the 81 interviewed professors, the need for a sometimes stringent selection of course materials was so apparent as to be obvious. But that this selection should almost necessarily result in extensive lecturing is less manifest. To show how selection leads to lecturing, we will here sketch some highlights from a voluminous supply of interview materials.

The 81 professors shared a key goal. The core aim of an undergraduate course is to move students along towards greater understanding of the course's disciplinary (or sometimes interdisciplinary) contents and towards an increased ability to manipulate them suitably. The more this brings students within view of the advanced level at which the discipline's practitioners carry out their work, the better. In such terms, one chemist's course approached the ideal: "I start with students who have essentially no knowledge of organic chemistry, and really, with the present methods of instruction and our sophistication and knowledge, the students end up as quite competent organic chemists after only one year of lecture work." Lecturing, be it noted, was integral to the students' achievement.

To achieve their goal, instructors may need to counter unacceptable student definitions of desirable or achievable course goals. A philosophy professor found that

> So many of the students are anti-intellectual. They don't want to work. But I don't tailor my lectures to this. I am not going to betray the occasion. I won't give them anything less than what I think is the best, necessary, most useful lecture.

To many the best kind of undergraduate instruction within an academic's reach is, in an English teacher's words, "a really good lecture, as informative, as pleasing, as well-organized, as instructive, as delightful as it could be." The lecture is more informative and more pleasing because it is the form of instruction most directly under the instructor's command. As a historian put it, "I am the professor in charge; I am in control, and I can adapt a lecture in whatever way will make it the best and most fruitful learning experience for the students in front of me." The lecture succeeds, in these teachers' view, because it so directly engages the professor's skills and abilities, in sustained pursuit of appropriate course goals.

Control of a course requires control of its materials. And teachers found that selection of the right materials almost never began or stopped with the choice of a textbook, because no textbook could fully suit their objectives. An economist said that

> The first time through a course, for all my courses, I set up the course independently of any textbook. I have to look at all the material I can. Then I try to find materials that fit

> -- either a textbook or various readings I draw together -- but I'm not usually too successful at this.

So he produced his own materials, in the form of lectures, adding that he generally made "very detailed notes for lectures, at least the first time, particularly for technical courses."

Professors stress that they feel obligated to design their courses "independently". Indeed, they are hired as men and women highly trained in their disciplines, to provide course instruction as their disciplinary judgment deems fit. As a chemistry professor put it, "There are very few undergraduate courses in my field which could be taught without the presence in lecture of an expert in the area, and have the students come away with any sense of what is important in that area of the field." How else, that is, is an expert to transmit, or arrange for the transmission of, the knowledge that matters, than through the "presence in lecture" of that expert in a classroom?

The double obligation. Selection always has two facets. The chosen materials must depict disciplinary topics well, and they must engage the students. To a botanist, as to others, both are basic: "I love my subject, and I have a great desire to make it clear and interesting to my students." Professors find in lecturing a key to fulfillment of this double obligation.

Sometimes the requirement of the discipline is the point of departure, and the problem is to "put the topic across" in class. As a major instance, our respondents described new developments as salient parts of all the disciplines we studied. Undergraduate courses thus need to show their subjects as evolving. To keep their teaching up to date, professors routinely collect new material throughout the year, and then use it to shape a lecture into final form just before a class. A sociologist's account is typical:

> All along I'll be looking through books I get in, journal articles I read, or even everyday newspaper accounts or magazine articles. I'll send for a reprint, or clip things, and put them in a folder I keep for the course. The night before a lecture, or the morning before if it's an afternoon class, I'll pull out my materials on the topic, read them over and jot together a presentation.
>
> If I don't do this -- say we're interviewing a candidate for a position and I can only spend 20 minutes preparing -- I'll rely mainly on material I've used in the past, and I find I'm very uneasy with the lecture. I have cheated the students.

Some professors find ways to describe their own research in class, to provide first-hand evidence that their field is growing. An economist speaks of new light on the causes of the Great Depression, and illustrates from his work on the early Federal Reserve. A psychologist describes his most recent paper to his statistics students, to show that "the statistics researchers use are changing," and to demonstrate that even the new textbook is "a little dated." Describing their own scholarship, several professors said, often roused particular student interest. And the only way to present it, or other very recent materials, was through lectures.

Adherence to disciplinary dictates, on the other hand, could meet with considerable student disfavor, or produce scant learning. A physicist believed that

> . . .students should be interested in work and energy. It's an important political issue, it's important in science. But it never seems to strike students that way, and in general, they don't do very well on exam questions about it. As a matter of fact, it's not terribly interesting to develop ideas about work and energy from other aspects of physics. That's a rather dry approach, but we try -- I try -- to emphasize a unity in physics by showing how one part is connected to another.

Each year, he said, "I'm a little apprehensive when I give this lecture; I perhaps expect to be disappointed." But he would continue to give it, because his sense of duty to his discipline took priority over his sense of failure with his students.

Instructors can also make their start from the student side of the double obligation. Students hold erroneous conceptions and distorted stereotypes about disciplinary topics, for instance, which need rooting out. "The teacher's job is to replace ignorance with accurate knowledge, and this of course means trying to dispel gross misperceptions of my field," one put it. A psychologist found students "want to know what's happening now; there's something intrinsically off-putting for them in the fact that psychology has a history." Notwithstanding, some of that history belonged in his lecture on motivation. History itself has a different problem. A historian's students "always think history happens to somebody else." So his lectures on the Depression showed how its impact "here in Kansas" was one of the worst. His statistics proved how widely Kansans had been dispossessed; he recounted what it had meant to his Kansan grandfather to be unemployed for years -- all this "to make them identify with it." A physicist, to counter an incorrect image, designed a demonstration:

> Students tend to think science is for scientific equipment, and doesn't have any application to the rest of the world. So recently in discussing kinetic theory of gases, I demonstrated the effect of gas molecules hitting a wall, by turning a book on edge and hitting it with various size balls. They would see there would be force exerted on the book by the collision, that would depend on how fast I threw the ball and how heavy the ball was. These things are involved in a rather complicated derivation, and I wanted them to see that the results of the derivation were realistic.

Only in a lecture, surely, could a teacher movingly describe his grandfather's travail, or quickly illustrate a theory with a book and some balls.

The teacher's double obligation of course finds expression in a hoary teaching axiom: a teacher makes students more interested in a disciplinary topic if he connects the topic to their daily experience. Our study produced a small host of illustrations for this principle which professors considered "only possible" or "best served" by lecturing. A political scientist provided a characteristic instance:

> In my lectures on bureaucracy, I talk about functions and dysfunctions. In the classic

> Weberian sense, the function of written rules is to better control and coordinate people. The dysfunction, of course, is a certain amount of inertia, intransigence, and goal displacement -- the rules become the goals. I try when I can to apply concepts to students' everyday lives. So I talked about the way rules work at the university here. A teacher is required to give out a syllabus with specified contents -- course goals, a schedule of topics, a date for the mid-term. Invariably, extenuating circumstances arise that keep a student from taking the exam that day. And I make the point that various professors are unmoved by the extenuating circumstances, however obviously real these may be, and stay totally inflexible. The students are very receptive to this, and volunteer good examples. They can identify with this instance when we go on to religious, economic, military, and political bureaucracies.

Not very surprisingly, in that identification students were the victims, and professors the perpetrators, of the organizational dysfunction.

Selection: The course textbook. Since instructors rarely depend solely on lectures for a course's total instruction, their classroom lecturing periodically deals with or refers to the other sources of instruction in a course. Teachers' approaches to course textbooks provide a good example.

A textbook, once chosen, brings with it a great deal of prior selection. Its cullings involve not only its author's choices from the oversupply of disciplinary materials available, but also, unless it is the first text on a subject, draws on prior generations of cullings. In no case did the 81 professors find the textbook's set of gleanings for a course identical or even closely similar to their own preferred set. So it was important in their lectures to deal with the text itself or to make additions to it. Even a physicist who defined "a successful undergraduate physics course" as one which "uses a textbook which goes along fairly closely with the lectures" needed to point out the most important sections, to clarify passages the students found difficult, to make themes explicit that a chapter left hidden, and so on. A chemist believed students deserve help with any text: "I don't see how I can expect students who are taking five or six courses to know everything that is in the book; I feel that I have to give them some direction in my lectures, to put emphasis on certain spots." An economist considered the teacher's sheer physical presence useful: "Even if the lecture material is pretty much the same as in the textbook -- and it is often not -- somehow a human body up there presenting it, with emphasis on certain sections and making it more concise, does help." When lecturers speak directly to a text, they refocus its disciplinary contents.

To our respondents, courses also benefit when their lectures offer other viewpoints than the text's. One chemistry professor considered it a "requirement" that he "attempt to present at least the material of greatest interest in a way other than the textbook itself, so that the students have a second approach to important course matters." A historian made it a rule "to complement the textbook in the lectures." In one course students could "get the names and dates and hard data of history out of the book," so he "used the lectures to elaborate, to interpret, to develop parts more deeply"; in another the

assigned readings stressed interpretation, so his lectures concentrated on the "hard data." If the lecture's posture was a creation of the teacher's, so much the better. A physicist considered particularly rewarding a lecture which "lent itself to giving my version of the subject, atomic structure, a version which happened to be different from the textbook we were using." Whatever the alternative approach, instructors needed to present it by lecturing, to make clear to students how it fitted with the textbook treatment.

For a really poor textbook, however, there is little remedy. A physicist who took over a course also inherited an unusable text: "I found it so weak in its explanation of basic ideas, or just so wrong, that in the lectures I first had to correct the book and fill in its omissions. Only then could I amplify it, in my lectures, provide some practical applications, and so on." Clearly, this professor differed sharply about the book's merits with the colleague who had chosen it.

Academics, in our interviews, often possess a clear personal vision of a best possible course for a subject, and devise their own contours for its best disciplinary contents. Lecturing, they say, is the method which best allows them to get things just right. As a botany professor put it: "Textbooks bring up peripheral matters one doesn't want to cover, and class discussion sometimes gets off the subject. The lecture has the advantage that an instructor can concentrate on the material which is most important."

Lecturing without a textbook. When a course has no text, different concerns predominate. A field is changing so fast "it's almost impossible to keep up" and "every textbook is out of date." Students can hardly be sent to the library to "read three books and four articles" the instructor can "better summarize in class." The material is too technical for students to grasp on their own. Students will only accept the violence in Titus Andronicus if their teacher describes for them the violence that permeated Elizabethan England. And there is always so much: a teacher "is simply overwhelmed with materials, and the problem is trying to decide about the 95% that might go into the lecture but which cannot."

Teaching a discipline's ways of thinking. Professors use lectures to show students how to think in the manner of a mature practitioner. A biologist arranged a set of experiments in a sequence which, years before, would have led to Pavlov's salivation reflex in dogs. In class he summarized the first experiment, asked students to design the second experiment to explore the result, reported the next outcome, and led them to think through a series of studies which culminated in the experiment by Pavlov. A psychologist sought to teach students how a clinician thinks. Himself a practicing therapist, he found that "students in the abnormal-psychology course usually lack a sense of how disturbed behavior actually plays out in everyday life; I try to use the lecture to provide vicariously certain kinds of clinical observation approaches you simply cannot get from reading." A

mathematician wanted to keep students alert as he showed them how to derive theorems. Would they please, he asked, point out any mistakes he made as he worked at the blackboard -- and casually scattered a good handful through the ensuing lectures.

Selection and lecturing. "Selecting," "choosing," "picking out," and like terms were not frequently employed by professors in our interviews. Yet teachers did certainly describe selection processes. Selection may be so inevitable, so important, and so everyday a part of undergraduate teaching that it is simply taken for granted. Anthropologists (e.g., Spradley, 1979) report that, in preliterate societies and modern industrial settings alike, a social group's most important norms can thrive unstated, so ever-present as to need no articulation.

We should note that other teaching methods, of course, also require selection of suitable disciplinary materials. But the interviews suggest that, unlike the lecture, these alternative methods tend to take root only in certain fields and specific disciplines. Part II of this report will include these findings.

Structure.

In contrast to their depictions of selection, teachers had a rich vocabulary for the activity of giving structure to disciplinary materials. They needed to "organize" or "reorganize," "sort," "synthesize," and so on. We will employ the word "structure" as a covering general term.

Inherent in the oversupply of teachable knowledge about a topic lies not only the availability of diverse selections, but also the possibility of diverse modes of organization for each selection. The very nature of a discipline's materials thus routinely compels teachers to work out their own organization of those materials.

And organizing leads by a number of routes to lecturing. A professor explained at some length:

> Lecturing has a relevancy that has to do with the faculty member as the one in whose hands the organization of the course rests. One has to pace the class, to direct it, to guide it, to provide focus. One frequently has to pull together important things, to provide reviews, to draw connections between past and coming classes. Students can't be expected to have access to the overview, the birds-eye view of the course subject matter, so they can't control things in these ways -- they can't guide the course, they can't pull things together. It's the teacher who presumably has been through the territory before and can lead others through it, in an effective way and not willy-nilly. It is fulfilling these obligations as a guide that makes lecturing superior.

A course requires its instructor to give workable structure to disciplinary materials which are inherently too unorganized for student comprehension. Lecturing, by providing pace and direction,

by drawing connections and pulling things together, becomes central to achievement of that structure. Thus for an English professor, "to prepare a lecture on the Gothic novel requires reading some Gothic novels, and some criticism on Gothics, and assimilating my own ideas with the critics' to draw some conclusions." He will read at least a scattering of such novels, by a variety of authors; he must review critical works, which inevitably differ in focus and in scope. He will add, to the disjointed notes which accumulate from these efforts, his own thoughts about Gothic novels. To this unshapely mass a suitable structure must then be tailored. Unless teachers can find another way to send students to the disparate sources and provide a map for them equivalent to the teachers' idiosyncratic structure, lecturing is required. The only real alternative is to write out the result and circulate it -- to lecture on paper.

To many teachers finding structure posed a challenge. A psychologist enjoyed this:

> Making sense out of something that is an undifferentiated blob -- organizing and structuring it, fitting in examples -- I like to do that. The organization comes first, then you find examples over a period of time.

Too, heterogeneous materials call for a forceful ordering hand. As an art historian noted, this can be "very hard work; one must find the best organization for the best, most current insights into the topic being presented, and that can be a great deal of trouble." A physicist found an unrewarding combination in familiar materials and an elusive structure: "Preparing a lecture is often difficult work, if it means going over material that's not too challenging to me, but that is not so easy to organize in a good way for students." A good organization had first to make very clear sense to the instructor who devised it. A biology professor, preparing a lecture on digestion, started from a judgment that

> The book was largely incomprehensible. So I re-synthesized the subject for the class. Digestion is a difficult subject to explain because of its complexity. The instructor, not to mention the student, needs to visualize several aspects of each step of a process simultaneously.
>
> Preparing the lecture, I found the only way I could personally begin to understand it and visualize it was to make a flow chart, as I was reading, of the sequential steps of the digestive process, and for each step to integrate structural and functional information. Then I thought, "Well, I understand it myself, now, on that basis," and I decided to use it in class. I prepared overhead transparencies, and led the students through the same process I had followed myself.

The organization seemed successful: "Looking at the students, I could see they were getting it -- and that was rewarding."

The ability to find a useful structure often has concomitants. For many professors, of course, a good supply of pertinent examples, or illuminating anecdotes, is essential. A social science instructor linked weak structure to a lack of enthusiasm: "Despite my preparation, my lecture on the Plains Indians ended up somewhat loosely organized; I was unable to be enthused about the material

in a way that would give me, at that moment on that occasion, the power to deliver my understandings of the book in a good way." Without the enthusiasm, a strong and moving portrait of the Indian tribe proved elusive. For an organization created spontaneously in class to succeed, an economist needed to "think logically on the spot":

> I had presented some material before, but it hadn't jelled, and the students were confused, especially about the graphs and assumptions. There wasn't any reading material because I had developed most of it myself.
>
> I started the next class by asking for questions, and realized the students were still confused. Then I hit on the idea of putting all four models on the board at once -- part in front, part on the side. I was getting excited, and the students started saying this was really making it clear for them, and this got me more excited.

Here the enthusiasm was mutual, and mutually contagious. And the organization came into being as a lecture in progress.

Devising the right structure for a lecture can closely resemble devising the right structure for a research report. As a psychologist notes:

> I prepare a lecture in much the same way that I write a paper. There's a long period of incubation when I'm reading background material and trying to sense the inner logic of the argument. There's a low-grade anxiety if the deadline -- for paper or lecture -- is approaching and I don't have my wits together. Then I begin writing, and things fall into place.

Some professors expressed the thought a little differently: in real ways, they said, the act of preparing a lecture is itself a work of scholarship.

The structure of a good lecture. The ingredients of good lecturing are complex, much discussed (see, e.g., Highet, 1954; McKeachie, 1978; Gage & Berliner, 1983; Brown, 1978), and for our professors, a subject of considerable concern. But the good lecture, per se, is not our topic here.

One desideratum does deserve note, because it on occasion led teachers to put the lecture's needs ahead of their discipline's. To several respondents, a successful classroom lecture requires a considerable degree of completeness within the hour; it covers its topic or topics as fully as the teacher intends in a single class session. Such closure, if made repeated practice, signifies both for teachers and their hearers that lectures have offered students all the teacher expects to offer.

But to give unity to each lecture hour, instructors may need to juggle. A sociologist who allocated two class periods to the Chicago School gave one 50-minute lecture on the statistical studies and a second on the observational works; without time constraints, he would have weighted the two aspects differently. A biology professor had a clear rationale for his regular goal of finishing up at hour's end:

> My lecture will go pretty much to the minute. I never carry a lecture over to the next period. I consider this something that needs to be done. When I was a student, I had professors who said when the bell rang, "Well, we'll continue this next time," and whether they really did finish it I never quite knew. My students don't sit there for five or ten minutes extra, wondering if they will miss something if they have to leave, or if they do leave not sure at the start of the next period if it's a continuation.

Neither instructors nor students, it seems, easily retain the clear flow and exact contours of a lecture if it is interrupted for 24 or 48 hours, or longer.

Translation.

The third attribute we found pervasive in all fields is the advanced nature of much disciplinary material. A good part of what instructors want to teach is in their judgment either too foreign or too difficult for students. So teachers seek to translate the foreign into more familiar terms, and to simplify the overly difficult to a level they believe students should comprehend. For both tasks, our professors found, lecturing was in general convenient, and often necessary. And it proved still more necessary when difficult materials also required selection and organization. A chemist's preparation of a lecture involved all three operations inseparably:

> I recently have been giving a few lectures on bonding in molecules. I had lectured on one theory of bonding many times over. The other theory I have rarely talked about, and had to brush up myself and become expert in. As I did that, I saw good ways to present a tough subject in a simple manner.

To pitch their lectures soundly to their students' level, some teachers made a deliberate effort to gain better understanding of their audience. A historian was pleased when he was invited to informal student gatherings, or to share a beer: "I want to know as much as I can about this particular age group of students, so I can adapt my lecturing to them, bring in analogies they are more familiar with, tie it in with something they already know." A sociologist obtained more systematic information. For his course in the sociology of religion, he said that

> I always establish the nature of the audience, their vocational interests, their particular background. I have them prepare a written statement, especially on their vocational aims and any religious presuppositions. This semester I've had a large segment of born-again Christians, and they often need different language.

Description of their classroom constituencies thus helped teachers choose a suitable vernacular for their lectures.

Translations not requiring simplification. Until recently, university professors habitually paraphrased the works their students studied. Our present-day professors did not speak of

paraphrasing; either they did it less, or did not think of it as lecturing. Their translations more commonly converted abstractions into visual or aural terms. A chemistry professor had waited for two decades for "cost-effective interactive computer graphics programs," which he needed to help students understand

> . . . the use of response surface technology in the consideration of the optimization of chemical processes. At last these computer programs can be had, and I have developed full-color computer graphics which illustrate exactly what a response surface is, for students who are unused to thinking in more than two dimensions at one time.

This particular translation required complex equipment, and a long wait.

When a change of language seemed a desecration -- Hamlet in modern English prose -- teachers tried instead to move students towards the original. An English professor explained:

> The language of Shakespeare, or of Pope, is very difficult for present-day students to understand. They're not used to metaphorical thinking. It makes tremendous troubles for them. But if one explains that kind of thinking to them, and takes a while to familiarize them with it, then one can work with Shakespeare or Pope.

In their own world, this teacher had noted, students wanted "face value on the page." So the right thing was to help them move onto Shakespeare's more exotic terrain.

Simplifying translations. Professors may, still more often, wish to translate disciplinary material they consider too difficult for undergraduates. Again, many teachers consider lecturing the best means for getting appropriately simplified versions of such material to students. According to an economist, "The general feeling in my department is that lecturing is good for most courses; economics is a difficult, highly technical field, and it is not well adapted to less formal methods." It is rewarding, as a teacher of literature put it, when "you are able in a lecture to make some sense of something very complicated, and their dark and troubled faces all clear up." The difficulty can come in finding the right level, or sustaining it. A zoologist experienced both problems:

> I have good command of the subject matter, and an ability to get myself down to the student level, at least some of the time. But sometimes I make things too complicated.

Professors often found the simplifying of complex material difficult. Success might disguise this difficulty, as a teacher of Native American literature noted:

> I was treating John Niehardt's Black Elk Speaks as autobiography, history, holy book, and ritual -- according to the expressive theory of language, four possible functions of a book. I wanted to bring the book alive for the students in terms of these four categories. And I was successful. I was doing something quite difficult with a great deal of ease, and much simplicity.

But another teacher's failure demonstrated the difficulty, and underlined the importance of success. A professor of chemistry described a repeated frustration:

> The lecture was dissatisfying because the course had to cover so much, I had to cut the subject down to a very short time. But I could not come up with a way of simplifying the topic without cutting it out altogether -- not an acceptable alternative. I left the students with loose ends hanging, questions unanswered, unable to apply what they heard to other cases, confused about the cases I presented. I've struggled with this subject for a few years, and have simply not found a good way to handle it yet.

This professor believed that "for these undergraduate courses in chemistry, we have no really viable alternative to lecturing." If he could not find a way to lecture on his topic in simplified vein, his students would not learn about it.

Criteria for the right level of simplification were also seldom ready to hand. Professors did not want to "go over the students' heads," but they did not want to "teach high school" either. Certainly the level could not be left to students. To a psychologist:

> The ratings I get say it's not my forte to "make complex things simple." Students feel I expect too much. Some think a nice freshman-level explanation is all they should be asked for. I want more out of them than that. I think my subject is a complex thing, and it can't be made simple. The students and I will disagree on that a lot.

For keeping his complex subject complex, he made clear, his ratings might suffer. An English teacher wanted to give lectures his students could understand, but not to mislead them about the intricacies of his field. So he added a caveat:

> I try to give as a professor professes. I don't have any secrets, and I don't want to tell them half truths. I'd rather tell them that as they go on in their studies, it is very hard to state the truth. It has to be modified more and more and more, the more you know.

This professor needed to balance three obligations: to the complex truths of his discipline, to his students' still-limited knowledge, and to their expectations if they continued study in his field.

Lecturing and higher knowledge.

If the arguments put forth in the preceding sections are sound, a further conclusion must be considered. This is that higher education as we know it cannot exist and function appropriately without a great deal of instructor lecturing. Individual instructors may find other methods, of course, and individual institutions may by policy sharply limit a faculty's lecturing. But a society's higher-education system as a whole demands extensive lecturing.

An institution of higher education is "higher" in the sense that it seeks to provide education on a high level, in disciplines which are themselves markedly advanced. Since at least the time in the Middle Ages when Western universities came into being, the advanced disciplines have each had a

body of knowledge so large that an instructor must select only part for teaching, so lacking in natural order that an instructor must actively organize the knowledge to make it teachable, and so often recondite in level that it must be simplified to make it comprehensible. This manifold work requires an instructor highly trained in a discipline, one capable of performing the three operations to bring students a version of the discipline which is still on a high level but in a form they can learn. Each of the three tasks, as we have sought to demonstrate, brings forth extended lecturing. Higher education teaches advanced disciplines, and in teaching them requires extensive lecturing.

In graduate school, the same considerations suggest, lecturing should at the outset continue widespread. In most disciplines, that is to say, graduate students begin work enough removed from a discipline's frontier knowledge and skills that the threefold teaching transmutation of the frontier materials is still required. Then as graduate students take on the tasks of skilled apprentices, the gap narrows, and the efficacy of teaching them by lecture declines.

Further, when graduate schools teach students the skills of research and scholarship, they teach skills directly needed for undergraduate lecturing. As our respondents noted, preparing an undergraduate course or class requires efforts close akin to those of scholarship. To a parallel degree, graduate schools directly train a discipline's new members for lecturing to undergraduates.

II. DIFFERENCES BETWEEN FIELDS

If similarities among disciplines lead to extensive lecturing in all of them, do differences between disciplines produce differences in the amount of lecturing? We know of no basis for generating expectations about this matter, so we must adopt an exploratory posture. The survey results will reveal that large differences do exist. To throw light upon these findings, we will make further use of the survey and the interviews.

For each of the four traditionally-defined fields we studied, Table 1 provides summary totals for the amount and type of lecturing. Table 2 records the counterpart totals for each discipline yielding a sample large enough for meaningful percentaging. (Respondents from the remaining disciplines, such as astronomy in the physical sciences and anthropology in the social sciences, are included in the field totals of Table 1.) We will often combine those who lectured for most of a period without interruption, 7% of the total sample, with those who lectured with pauses for student questions and comments, 73%, as the 80% who "lectured" for most of the class period.

Table 1 makes clear that instructors in both the physical sciences and the biological sciences lectured in this sense to some nine-tenths of their undergraduate classes. In the social sciences, the level of lecturing was a noticeably lower 81%, and in the humanities, a sharply lower 61%.

Table 2 reveals that in three fields the degree of lecturing was sufficiently similar among member disciplines to justify treating them together. However different chemistry, geology, and physics may be in other regards, they proved sufficiently alike in the teaching practices of concern here to permit combining them as physical sciences. The mathematics sample will be retained among them, because of kinship to branches of physics and chemistry that rely on mathematics, and because the lecturing practice of mathematians does not invalidate that kinship.

Botany, zoology and biology are often treated together as life sciences. The data of Table 2 allow us to follow suit (while recognizing that the zoology sample may be unreliably small).

The social sciences, except for economics, pose no problem. Economics, though clearly outlying in Table 2, also clearly deals with economic counterparts of the human behavior, individual and social, which occupies the four other disciplines. Including economics among the social sciences seems better than the only feasible alternative, discarding it from further analysis. Also, our interviews suggest that the five disciplines share distinctive disciplinary traits which shape their lecturing practices in recognizably similar ways.

But Table 2 makes clear that, for present purposes, disciplines in the humanities differ greatly. It was only the large representation of literature professors, who devoted just half of their class sessions to lectures, that created the low lecturing total for the combined humanities in Table 1. Both art historians and philosophers lectured as much as scientists. Literature alone stood apart by giving equal weight to other modes of teaching, and we will treat it here as a distinctive fourth field,

requiring separate exploratory attention. We leave art history and philosophy aside, as equivocal for our purposes.

Uninterrupted lecturing was considerably less frequent, in all disciplines and fields, than lecturing punctuated with student contributions. Only literature made this all but unanimous: Just one of its 95 sampled professors had lectured through a class without hearing from a student.

The role of class size.

For our sample as a whole, a familiar tenet of the received wisdom about lectures proved true: The larger the class, in Table 3, the more often it was taught by lecturing. The largest classes, true again to form, received almost nothing but lectures. But the reverse common wisdom received little support. As in Britain (Hale, 1964), professors lectured to a large majority of even their smallest classes.

The possibility arises that fields which differ in their emphasis on lecturing do so because they also differ in the size of their classes. If the sciences' enrollments were largest, literature's smallest, and the social sciences' in between, the lecturing differences between these fields in Table 1 might even be fully explained: The factors that made science classes large would account for science teachers' frequent lecturing, those making literature classes smaller would explain their reduced lecturing, and so on.

It is true that literature did have a larger complement of comparatively small enrollments. More than half of its classes had 24 students or less; in the other three fields, the parallel fraction was at most one third. Table 4 summarizes the relationship between field and lecturing, separately, for larger and smaller classes. (Uninterrupted lectures increased in all four fields in approximately the same measure, and are not separated from lectures with student contributions.)

The results make clear that none of the familiar lore about class size held true throughout academe. To be sure, in three of the four fields, larger classes did receive more lecturing. The marked pattern of Table 3, in dichotomized form, becomes in Table 4 a difference overall of 11% between larger and smaller classes. This difference falls negligibly to 10% for literature, and somewhat further to 8% for the social sciences and 7% for the life sciences. In the three fields, class size did matter, though sometimes less strongly. But in the physical sciences, it did not count at all: professors lectured, if anything, even more in their smaller classes.

Rather, it was the differences between fields that stayed essentially untouched. Two sets of comparisons from Table 4 illustrate this conclusion. Overall, the physical scientists lectured 38% more often than the literature teachers. The comparable figure for smaller classes was 45%, and for larger 33%; these average to 39%. The difference between the two fields was somewhat enhanced in smaller classes, and diminished in larger, but on average unchanged. Overall, again, social science

and literature differed by 30%; the comparable figures for smaller and larger classes, of 28% and 29% respectively, here stayed closely alike. Class size in no way accounted for field differences in lecturing.

Predispositions.

The principal argument developed in these pages is that the disciplines exert a potent influence in shaping undergraduate classroom teaching, an influence which operates directly and intimately on instructors to create continuing pressures to lecture. Such is the tenor of the interview quotations offered so far.

A very different type of explanation requires mention. Teachers' present behavior could arise from early predispositions, held before teachers took up their disciplines. Let us imagine two kinds of academics, A's and B's. A's were "born to talk," and, of course, today like to lecture. B's were "born to listen," and now prefer other ways of teaching. A's, when they chose a career, were more attracted to science, which they could usually teach by lecturing, than to literature, where lecturing is constrained. B's, choosing, took the reverse path. Differences between disciplines like those in Table 1, instead of reflecting contemporaneous pressures, could result from early selection processes determined by predispositions.

Men and women. Of the 820 survey respondents, 11% were women. On the average, male professors lectured considerably more frequently, to 82% of their classes, than did women, to 67% of theirs. Women were also better represented in literature (and the other humanities) than in other fields: They comprised 20% of the respondents in literature, 12% of the social scientists, 11% of the biological scientists, and a scant 3% of the physical scientists. Women found literature more attractive, or more open to them, than they found other fields.

If women were more predisposed than men to choose literature over science, and drawn by the field's distinctive attributes (to be discussed shortly), these attributes might have only a mediated impact upon teaching. They could influence instructors' initial choice of discipline, have no further bearing, and still produce contemporaneous differences between fields. Mediated influence would leave men and women completely alike, once their fields were chosen.

Table 5 presents our available evidence. Since the numbers of women were too small for assured conclusions, these findings must remain tentative. As such, they clearly suggest that predispositions were not a factor in literature, where the overall difference of 25% between men and women reappeared little altered as 24%. In the two natural-science fields, combined perforce because their samples contained so few women, mediation may have played a part. And in the social sciences, it may well have had real importance.

The topic, thus, deserves further study.

The physical sciences.

The interviews yielded rich materials on the disciplines' distinctive attributes, and the impact of these attributes on lecturing. We will begin with the physical sciences, which along with the biological sciences make lecturing most commonplace.

Teachers in the physical sciences take certain things as given. In the ordinary event, their classrooms are devoted to lecturing, and all present take for granted that students will not speak extensively. Characteristically, too, all assume that under teachers' direction, courses will include other instruction. With classes mostly lectures, this instruction must in the main occur elsewhere.

Outside instruction. Instructors explicitly counted on this further instruction to bring a course what their lectures might lack. Laboratories, according to many science instructors, would provide needed "hands on" experience. But to some the steady lecturing called for a more specific complement, to work well. For a physicist, this involved individual effort: "I hope they go home and read the book and work on the problems. That's the only way they'll get a lot out of the course -- if they work on it on their own." Another physicist formalized the expectation: "I continually stress that learning physics requires exercise and activity in the subject, just as much as learning to play tennis involves hitting the ball for hours on end." He insured this regular practice by assigning homework problems three times weekly, to be turned in and graded: "This gets the students into the text and thinking about the material outside of class several times a week." A chemist attributed to his lectures only an initiating role in the course learning process:

> I feel that most of the real learning the student does is outside the classroom. The lectures serve the purpose of defining what is to be learned, and getting the student started on that process. Doing the homework, and especially the assigned problem, is probably a more important aspect of the learning experience.

These definitions of the whole-course experience free instructors to lecture inside the classroom as much as they deem necessary.

Concurrent forces. Physical scientists describe five different attributes which characterize the body of knowledge they need to teach, and find all five best served by lecturing.

Three, as we know, are common to other academic disciplines. Again, hour-long lectures demand selection; a chemist said that "lecturing, in my estimation, requires that the faculty member first select material of greatest interest, so it becomes emphasized through his lecture work." Or the lectures add fresh viewpoints to the course. To another chemist, "the time for lecturing is to supplement what is found in textbooks, to provide students with other strategies for understanding -- to present ways for dealing with the same chemical problem using different principles," and lectures

should "fill in the historical background, not available in most textbooks."

However unified Einstein might find physics, to undergraduate teachers it can present disarray, and a need to provide structure: " The main thing I have to manage to do is to properly organize, so a has to follow b." A good result is not easily achieved, and is satisfying:

> I know when I have given a clear, well-organized lecture that was logical. I am sure that the average student understood what I had to say. I feel as I walk out of the class that I did a good day's work.

Feldman (1976), reviewing a sizeable research literature, found science students in agreement. More than in other fields, they consistently viewed clear teacher explanations and sound organization of course materials as central to good teaching.

And esoteric conceptions of the way nature works, like their counterparts in other fields, require simplifications, and lecturing. A visual rendering of the chemist's n-dimensional response surfaces needed elaborate video equipment, and explanation. A physicist, explaining modern physics in an introductory course, pointed out to students that there were

> . . . many new concepts involved. This is not classical physics, and the students can't rely on intuition based on everyday experience to understand. They seemed very attentive.

The three disciplinary attributes again each posed difficulties for teaching, and resolving these difficulties again led directly to lectures.

Distinctive attributes. The fourth attribute, however, is distinctive to the physical sciences. Characteristically, these disciplines seek right answers about nature. In Kuhn's conception, they look only at limited parts of nature, and pose very specialized questions. Researchers at a discipline's frontier seek further right answers, but have no guarantee of finding them. Though undergraduate teachers may acknowledge this frontier uncertainty, our interviews suggest that for the level of science they teach, right answers are almost always available.

Science teachers, as noted, often expect students to produce some of these answers on their own, by studying the text and working problems. But these teachers also add two provisos. They expect students to deal with problems on a topic only after hearing a lecture on it. And they find students capable of solving only the simpler problems; more difficult matters need lectures.

In lectures, indeed, science teachers see varied possibilities for bringing complex truths to students. Demonstrations can show how those truths work. They may demonstrate only an analogy: lacking a movie of gas molecules bouncing off container walls, they show balls bouncing against a book. Sometimes they can demonstrate realities: a collodial suspension emerges in a glass tank at the front of the lecture room, or a blue crystal diffuses slowly into a clear liquid on a high corner shelf.

A translation or simplification may be useful: The workings of response surfaces are more readily comprehended as color video graphics than as mathematical abstractions.

The complex right answers which teachers reserve for lectures, according to respondents, also become more convincing when produced by some clear process of logic, such as algebraic derivation. And problems which use the resultant formulas become more manageable for students to do outside of class, once teachers work through clear models inside.

Elegance. The physical sciences' focus on right answers can be difficult to separate from a fifth attribute of importance to lecturing, which we will call cohesive elegance.

A physicist provided a succinct illustration:

> I found the lecture rewarding, because I was explaining to a large body of people, in an economical and hopefully elegant way, how electric circuits work. This is presumably a specific feature of physics -- we like to explain in terms of a few ideas.

As quoted earlier, another physicist sought to "emphasize a unity in physics, showing how one part is connected to another with mathematical derivations." Economy and elegance appear in mathematical formulae, which summarize in a few symbols and numbers the way complex events occur in nature under greatly varying circumstances. The unity and cohesion become manifest when the teacher uses these scant tools to produce derivations of formula after formula, describing different parts of the physical world with considerable precision. Each blackboard derivation, of course, involves a spate of lecturing.

Interestingly, the elegance was often accompanied by intuition. For the chemist using computer graphics, intuition reached towards larger patterns hidden in the complex mathematics:

> I found it rewarding to communicate to the student my intuitive sense for the general, overall response of a multi-dimensional chemical system. This is a new concept for them, and I enjoy conveying the excitement that I have concerning the particular type of thought, and seeing them respond.

With the teacher's intuitions came also excitement over a new mode of thought.

For our "cohesive elegance", some chemists might prefer "elegant cohesion":

> In organic chemistry, our increased knowledge permits us to present a much more cohesive body of material. We can present it more rapidly, and in greater depth, today, than before we reached our present level of sophistication.

When the cohesiveness of material depended upon mathematics, or tight logic, instructors needed to present that logic in lectures.

The small lecture. According to much received wisdom, lecturing to a small class is undesirable. As Boyer (1987:150) puts it, lecturing is "inappropriate . . . when the class is small." Yet as the figures in Table 4 clearly show, professors in three of the four fields lectured through at least three-quarters of their smaller classes, and in the fourth field through almost half. The physical scientists, in particular, kept to their lecturing as much in small classes as in large. Appropriate or not, such lecturing was in fact the norm.

Indeed, as the figures hint, the scientists sometimes viewed the small class as an advantageous setting for lecturing. For a chemist, a small group in a small space meant a superior atmosphere for learning:

> Lecturing in a small room means that everyone can see your face. You can speak in a conversational tone, without amplification. This creates a much better atmosphere for learning, and I find, gets a much better response from students. You can write on the blackboard, and not need a projected image on a screen.

The easy tone, the nearness of the teacher, the informality of a blackboard, all contributed. Others assumed that the increased participation they noticed was only possible in a smaller class. A physicist, after an implicit bow to the conventions, explained:

> When I teach even a rather small course, to only a few students, I must say I probably spend about two-thirds of the time explaining things to them in lecture fashion, but of course with a lot more interaction from the students as to what they understand and what they don't than you can have in a large lecture.

Other instructors noted that when the group was large, students seemed intimidated about taking part, and appeared willing to be physically present but mentally elsewhere. In a small class, they came more under their teacher's eye, and their classmates', and felt easier about talking. A physicist spelled out clear expectations, in expressing his disappointment and dire predictions for students who disregarded them. In a class of 16, he said,

> . . . about half seem to come just to watch, take a few notes, write the quizzes, and turn in their homework. But no class participation. I feel I am making no contribution to their development, that their notes will soon be lost, and that whatever they have been exposed to in the course will be of minimum utility.

For this professor, clearly, a small lecture made student interaction not only possible and desirable, but imperative.

Why not 100%? If teachers can collectively put 90% or so of their classroom time into lecturing, why don't they go all the way, to 100%? One answer to this question is that the physical scientists (and professors in other fields) sometimes lecture under pressure. Where 89% of all such scientists in fact gave full-hour lectures, a noticably smaller 75% said that lecturing was their overall

preference for teaching undergraduates. The remainder liked other methods as well or better. The difference in percentages provides a crude indication that these teachers felt a certain pressure to lecture.

The interviews confirm a degree of discomfort. A good number of these professors, when they could, had tried other teaching methods. Too often, they were disappointed. Students asked to do simple class demonstrations turned out not to understand sufficiently the principles of physics involved. Weaker students did poorly in discussions. On their final exams, students a teacher gave much time in individual tutoring retained the principles he "repeatedly emphasized" no better than a large group of lecture students did. Reluctantly, these teachers went back to lecturing. When teachers did convert, to discussion or some other method, it was not because the nature of their disciplines' body of knowledge created a patterned need for use of the alternative. For the lecture, in contrast, they created a need in five-fold abundance.

Thus it was the desire for other kinds of teaching, if only sometimes converted into action, and when converted only seldom successful, that put a cap on lecturing. And further, when teachers did convert, to discussion or some other method, it was not because the nature of their disciplines' body of knowledge created a patterned need for use of the alternative.

The important dimensions of science.

We pause briefly to raise a question: Are the dimensions of science that matter most to undergraduate teachers the same dimensions that matter most to those engaged in research? Is the science that college and university instructors seek to pass on to undergraduate students the science that frontier workers seek to advance? Let us use Kuhn's portrait as a test.

Perhaps the most salient attribute of science, for Kuhn, is its practitioners' high agreement on foundations, rules, procedures, and language. Undoubtedly, undergraduate instructors also agree on much. They teach the same formula to describe the collision of gas molecules, and the same set of Newton's laws. But what are we to make of a textbook, well suited to one colleague, which another deems incomprehensible? Perhaps, when different instructors select among complex materials which possess considerable higher unity, and individually organize and simplify them, that the lectures which result diverge substantially more in content.

Again, researchers are presumably at home with the esoteric nature of science. Their work, if anything, makes it more esoteric, testing ever more refined hypotheses, and using yet more exotic equipment. But teachers' task is not to refine science, but to make it comprehensible to the uninitiated. They must tame the esoteric sufficiently to render it understandable to ungergraduates. And again, science researchers' focus is expected to be narrow and specialized. A teacher cannot concentrate on one small part, but must find ways to interest students in a whole sizeable sector. Yet

again, science research is geared totally to the solving of new puzzles. The teacher's job is to deal mainly with former puzzles -- to show undergraduates their solutions and perhaps how they were solved, to teach students to understand them by solving homework problems, and so on.

To do their work, undergraduate teachers must view their disciplines from a stance quite different than researchers'. A central part of that stance has provided the subject for this paper: To deal with their discipline, teachers need to manipulate its materials, and to lecture on the results of the manipulations. Researchers, however demanding their work in other respects, are not called upon to transform their discipline's contents before they can use them.

This is a good place to point out that the dimensions of a discipline which help to shape its teaching methods undoubtedly also affect other aspects of undergraduate education. For instance, the disciplines have distinctive teaching goals (Vreeland and Bidwell, 1966; Gamson, 1966) and distinctive ways of encouraging talented students (Thistlethwaite, 1962). Those matters, and others beyond our immediate concern in this paper, surely also reflect the characteristic nature of a discipline's knowledge.

Literature.

Literature is the field which contrasts most sharply with the physical sciences in its undergraduate teaching practice and in the nature of its distinctive disciplinary attributes.

Teachers of literature hold a quite different set of givens. They take for granted that original works of literature form the core of their disciplinary materials. They assume that in literature courses, students will read original works, and that the course will be devoted to studying and understanding them. Literature courses have no textbooks. Students may read criticism, hear background lectures, or research outside papers. But they deal with the course's literary works in their original texts, not through a mediating textbook. Teachers and students alike take for granted that literature is not a field taught principally by lecturing. Some courses are lecture courses, numerous class sessions will offer mainly teacher lecturing, but no department will present only lecture courses, no suitable undergraduate education will consist primarily of lectures.

What constitutes for literature the proper amount of lecturing, however, is far from given. Departments, instructors and courses vary considerably in this matter. Our respondents say that the frequency of lecturing in literature classes may vary considerably over the years, altered by changing fashions in teaching. But the line between lecturing and other methods will be drawn inside the classroom, not outside, as with the physical sciences.

A professor summarized his discipline's goals for teaching:

> So many other disciplines are basically the conveying of information -- factual, opinion, whatever. Naturally, in literature, we too convey a good deal of information in our lectures. But in literature courses from the freshman level on up, we are confronting a

> text and attempting to create an aesthetic experience, one that is different for each time and person.

The distinctive traits of literature center in the richness of the works it studies, and in the inherent individuality of responses to them. Teachers of literature confront these twin attributes, and attempt to create a sound student learning experience, by mixing lecturing with discussion, and sometimes with other teaching methods.

Literature's distinctive attributes. In institutions of higher education, professors of literature deal with authors of substance. One professor taught Eliot, Pound, James, Samuel Beckett, and others in whom

> . . . There always is something new to be found. Otherwise we wouldn't be teaching these texts. Perhaps the principal criterion for literary excellence, for judging a work excellent, is that it is inexhaustable. Every time you approach it you see something you did not see before. This means that the text itself signifies many things, and that you are changing and growing and having different experiences.

Another teacher spoke of the high "artistic creativity" of the works he asked students to read. In these works can be found layers and facets of meaning, their key points can be deeply hidden and reached only by small surface clues. No formula applied to a literary work will produce a single, right mathematical answer. A work's truths are diffuse, transient, even contradictory, and seldom all available to one reader.

A work's meaning is thus never fixed or certain. Truth in the physical sciences lies in nature, outside humans and human influence, established by an algebraic equation and a set of bounding conditions. The truths of a literary work lie as much in the reader as in the work. Macbeth with no audience is like the philosopher's tree that falls in the desert; it cannot have human meaning until it is experienced. Readers' selective focus, circumstances of the moment, and general sensitivity, all help shape the truths they acquire from a work of literature.

Teacher's obligations toward their subjects are correspondingly undeterminable. One's mastery cannot be guaranteed complete, surprise must be always possible, Eliot and Pound should be "approached" again and again. One professor said he could indeed reread the day's assigned short story repeatedly, over the years, and take a fresh experience each time to his students.

Teachers' obligations to their students are clearer. The truths student readers find in a literary work vary in their value to others, and in their quality as judged by the students' more seasoned mentors. Teachers of literature seek to improve the value and quality of students' understanding through a variety of means. They help students learn to read a work closely and repeatedly, and to share thoughts and feelings about it with others. They provide useful background -- facts about the author and his times, the location of a work within a literary genre. They explain how the technical

apparatus of writing underscores and enhances meaning. They describe how leading critics, and they themselves, interpret a work. In the process, they do often lecture. But they also rely extensively on class discussions.

The importance of discussion. A full documentation of the 81 professors' experience with the discussion method is not needed here, nor is a review of the extensive literature. Blackburn et al. (1980) show that while discussion runs a distant second to lecturing as instructors' choice for undergraduate classrooms, it is nonetheless the only other method used with any frequency.

The interviews leave no doubt that, in aggregate, professors of literature and their departments counted heavily on the discussion method. (Erdle and Murray, 1986, obtained a similar finding.) Some professors also disapproved of the lecture.

> There is a departmental antipathy toward the use of lectures, particularly in the Introduction to Literature course. Some colleagues say it is imperative that all class meetings in Intro courses be discussion sections. I don't agree. I find a mix is the most profitable.

Teachers valued discussion in particular for a specific use to literature. They found it a good setting for students to practice and learn close reading: "We sat over a Donne poem and read it with care for an hour." Another professor told his class that "we are sometimes, as students, not reading closely enough, and are overlooking the perspective that the author presents us." Thus a work by Frank O'Connor describes the fate of some prisoners only by saying that their captors took the prisoners "over the hill towards the west." In the ensuing dialogue, the instructor concentrated on the single word "west". (Student voices are in parentheses.)

> Do you understand what he meant by "over the hill towards the west"? (Not very well.) Well, what happens in the west? (That's where you go to reach the frontier, to make your fortune.) Yes, yes. Is that what's happening here? (No, it makes no sense.) What else happens in the west? . . . All right, what happens in the east? (The old world . . . Isn't that England? . . . The sun rises.) And what goes down behind the "hill towards the west"? Yes, yes, so what really happened to the prisoners in that sentence?

The professor led the students to discover that the prisoners had been executed, and that the person telling the story wanted to skim past this hard fact with a soft metaphor. It was important for the success of this interchange between teacher and class that, though the metaphor was outside students' experience, the word "west" was not. Another teacher used a pair of comparisons to show how different the same work can look in different settings. Comparing poems by Robert Frost and Thomas Hardy, the students decided, made the Frost "look relatively stern." Then "we shifted the context and compared the Frost with a Robinson Jeffers poem, and they saw the Frost philosophy was remarkably soft, like running marshmallow, against the philosophy in the Jeffers." The

professor could have made the same point by lecturing, perhaps more quickly. Yet as another teacher put it:

> Discussion can provoke thought that a lecture may not. Minds become engaged in discussion when it is working well. It can be very exciting for me, as the teacher, too. Discussion is absolutely invaluable.

Students may take more to heart the ideas about literature which they work out for themselves, under guidance.

Teachers saw other benefits. A lecture is one-sided, even authoritarian; participants in a discussion are more equal: "In my field, lecturing is not the appropriate way for approaching how a poem works, or how a novel works; there one needs the give-and-take of the small discussion group." Give-and-take puts participants on the same footing; it assumes that students can find truths in a poem of sufficient validity to deserve attention from an entire class.

Discussions thus legitimate and display the presumption of intrinsic worth in student interpretations of a work of literature. This good standing was underlined in instances, not extremely rare, where teachers preferred students' ideas over their own:

> I picked two passage from the Odyssey, one because I thought it was the very quintessence of narrative, of the whole man being summed up in a particular incident, and the other as a superb example of the dramatic. I gave the students the two passages, and asked what they saw in them. What they came up with was very different, and much better than mine. The first showed the Apollonian side of Odysseus, the second Odysseus as Proteus, always changing guises.

Teachers took special pleasure in such incidents, which epitomize the student reader's direct access to truths, and even in great works of literature.

Professors valued discussion also for its group products -- for things students learned about the variousness of literature from each other, and for new ideas that developed from the interaction:

> From discussion, students learned the possibility of profiting from disagreements with each other. They learned that variety of opinions is not a threat. They need to see the variety of possible responses to the same thing, that they may be valid. This enables one to move on to freely choose the best.

This instructor does not quite say so, but we can assume that in a roomful of equals, he was most equal of all, the one person present who had expertise and experience at choosing the best.

The teacher's role in a discussion may camouflage that expertise, or should: "I do tend to dominate discussions; I am working hard on being more receptive to student opinions, on listening, on giving students more time in a discussion section than I give myself." This instructor lectured more than he intended. But a teacher's talk can lead students to important conclusions, by articulating the implications of their comments:

> I talked to and with students about their remarkably different interpretations of a poem. Together we tried to figure out where the different views "came from," and to adjudicate between the "anything goes" and "One True Reading" extremes.

Once the adjudication process was finished, the students would know where their teacher stood, and even recognize his discipline's one true standard interpretation, yet remain free to advance a defensible reading of their own. In general, Feldman's (1976) review of the literature showed, humanities students particularly value teaching which challenges the intellect and encourages individual thought.

The short lecture. Along with discussion, as the figures of Table 2 make clear, professors of literature also devoted half of their classroom time to hour-long lectures. As examples have already demonstrated, they like others responded to the threefold difficulties of their disciplinary material, by selecting, giving structure, and simplifying, and by presenting the results to students in lectures.

Unlike the physical sciences, however, the field of literature possessed no salient trait which would still further induce professors to lecture. At least, we found no signs of one in the interviews. On the contrary, the variousness of meaning so prominent as a feature of literature led professors primarily away from full-hour lecturing, to classes which combined discussion with short lectures.

Perhaps surprisingly, professors gave only brief mention to the kind of lecturing that precedes and leads to discussion, often at the start of an hour. They seemed to take for granted that providing background was repeatedly needed, a task they did well enough, but not a topic of great interest for our study. As one respondent put it: "Any competent professor can provide the facts, though it may take work." Perhaps a short lecture needs only a short preparation, or its background materials come ready to mind, or the necessary selection and organization seem comparatively routine.

Our professors showed much more interest in the kind of short lecture that follows a discussion. One, asked at the end of the interview if we had left out anything important, wanted to discuss "the manner in which the discussion at the beginning of a class can serve as a springboard for me to deliver a more formal presentation." Perhaps teachers' concern arises because, though the opportunity may be spontaneous, the lecture itself may need advance preparation:

> The lecture for me is often an informal talk, or it takes on the appearance of an informal talk for the students. I don't often write out my lectures. Some I keep in outline form, in notes. Sometimes I just have them in mind, in units which can be arranged and rearranged, lengthened or shortened, etc.

This kind of lecturing ought not to begin abruptly, but should emerge from the discussion and develop the discussion topic:

> The discussion preceding the lecture led right into the lecture very smoothly. The

> students contributed to that. They helped -- to set the tone, to set up the problem, to define the situation. I was able to move easily to a body of ideas I wanted to present to the class, and I didn't have to go about it in a formal or mechanical manner.

If teachers come to class "prepared to talk" and "focused," as one put it, they could steer purposefully towards the lecture. And such readiness means the instructor "does not have to depend on the random initiative or perhaps indifferent remarks of the students as a far more unsatisfactory springboard for the lecture." The more a lecture appears to grow directly from a discussion, the more it becomes a natural part of that discussion, a democratic contribution by a well-qualified participant. And the discussion can seem even to start a short lecture going without the teacher's instigation: "In a small class which is basically a discussion group, a question will arise, and I find myself launched into an extemporaneous lecture of 10, 15, 20 minutes."

The short lecture most directly linked to literature's amorphousness occurs when professors describe for students what a particular work means to them. One professor, fresh reading of a literary work in mind, often finds mid-discussion that " an idea will come to me, and I begin to talk." Another described himself at such moments as two persons, one standing aside watchful or even in awe, and the other creating right words and apt phrases:

> The lecture turned out to be very informative, very insightful. I found it inspiring to me, and I think it was inspiring to the students. I found myself saying things I didn't know I really knew, in a very appropriate way, in a way I had never said anything before.

Such talking can inspire students to find new meanings for themselves -- or, of course, to embrace their teacher's reading without further thought.

The short lecture may offer students a more technical set of tools:

> I've had some success conveying the fascination and importance of discovering the formal mechanisms an author employs. "The Scissor Man" is a clever, witty, short poem. To discover that the stanza structure of the poem, its use of hyphenated compound words, illustrates some things about the character of the scissor man and the situation he is in -- that discovery can show what makes language constructions work and communicate and give pleasure.

This instructor was a reader sharing "views" with students, and a professor giving them a quick kit bag of technical expertise, to assist them in both ways towards heightened appreciation of an author's artistry.

<u>The social sciences.</u>

In the social science interviews, textbooks appear again. With the texts come comments so similar to those made by physical scientists as to be interchangeable: Good texts are hard to find, lectures should complement them, and so on.

Social scientists, once again, share three tasks in common with other academics. They must select: "There are 100,000 studies on schizophrenia, and I have to cover the whole topic in three days." They must organize: "Students become very antsy, very edgy, if a lecture doesn't hold together." And so on: Fields are changing rapidly, preparing a lecture requires scholarly activity, some topics are intractable and make for poor presentation, large groups are reluctant to talk, small groups take active part.

The social sciences focus on the study of human beings and human groups. The distinctive characteristic common to these disciplines, which affects their classrooms in recognizable ways, is best reached by beginning with two important lacks. The social sciences lack a firm point of anchorage in the world of nature, with its expectations of right answers and replicability, and of being for both teachers and students "outside of us." Social science also lacks the canonical texts which give literature a very different anchorage. Hamlet may never be fully fathomable, but its words are there, a shared launching place for all. The social sciences must treat their human topics without either kind of starting line. Our interviews suggest that the result, when such kinds of guidance are lacking, is a greater dependence on both teachers and students as a source of authority.

Instructor authority. Teachers' special authority finds expression, often, in the importance they and their students attach to classroom lectures. An economist used computerized models in one course, but in his others, he said, students got "everything out of the lectures, and very little from their readings." It was the lectures that counted for the exam, not the textbook. A psychologist explained:

> The exam has some items based on the text, some based on the lectures, and some on both. But the students usually do better on my lecture notes, even though I feel my lecture items are harder. Sometimes they tell me, "I can just come to your lectures and get enough out of them to pass the course." They quickly realize the parts I've emphasized.

This teacher appeared to offer token resistance to so much reliance on his lectures, by making the lecture items tougher. But on the whole, he accepted and encouraged that reliance.

Social science teachers did not always relish the special place their lectures held. A historian who noted that "the students here tend to be very deferential to professors," explained that they lacked self-confidence, and he found them "difficult" to teach. A sociologist reported a repeated drift:

> I've noticed that early in the course people are more talkative. But somehow I discourage input. By the end of the class, I am lecturing and they are listening.

Part of the problem, he thought, was that "sometimes I try to cram too much into a lecture, and it discourages them." In such ways, the social science teachers seemed to give their lecturing added

weight, and added time. Yet as the tone of these quotations makes clear, the teachers were not well pleased when it proved so predominant in their classes.

For they believed that their courses should "challenge" students, and that lecturing might inhibit this. An economist's small class, he said,

> . . . enables the students to get involved, instead of being so passive. One of the problems with lecturing is that students take in knowledge, and don't become active, in the sense of really assimilating it. Somebody is putting it in, rather than the student reaching out and getting it in. It's like being pulled across the street, instead of walking across.

And it was not enough, as in other courses, for students to look alert, take vigorous notes, or nod and smile. They should also take part by talking.

Student authority. The students agreed. They expected to talk, and talked willingly. They could indeed use their personal experience to illustrate their teachers' points. A sociologist said:

> In a lecture on white-collar crime, I had everyone's attention, by making them familiar with the pervasiveness of white-collar crime and its great cost -- something much more serious in terms of its burden on society than the property crimes that disturb us more. I asked if they could recall, from any occupation they or their family were in, the kinds of criminal activity in the occupation. I got a flood of episodes, particularly describing misrepresentation in selling.

Students' classroom talks acquired legitimacy because their lives provided clear examples of social science pronciples. A psychologist liked to have students take part in demonstrations to provide a different kind of legitimacy:

> When I can, I like to talk about a phenomenon, and then have a student or the whole class immediately reproduce it, there in the classroom. For example chunking, a way of putting information together in chunks, so you can remember a lot more than seems humanly possible. I give a student a sequence of 48 0's and 1's in random order, give him some instructions for over the weekend, and have him say then back in class, perfectly. The students recognize that he is one of them, and that they could do it too. When it's not just "memory," but their memory, they remember it.

The demonstration gave "chunking" direct veracity. And in the process, for a few moments, a student got to talk. Other students were determined to talk, and sometimes did so without any course mandate. According to a historian:

> Some students definitely want to challenge you; it happens all the time. They push. I had one student who tried to nail me to a wall. But they couldn't do it, because I teach very objectively.

Social-science teachers spoke often of "politicized topics," and "argumentative students." Students

had views on homosexuality, on Christianity, on the Democratic party, the Great Depression, and Freudian theory, and sometimes expressed them more than asked.

In any case, when students were supposed to answer questions, or ask questions, they tried to comply.

A fragmented authority. The social sciences possess no central source of disciplinary authority. Each of these fields has had Founding Fathers, but those dignitaries leave no constitutions, no sets of binding rules for all sociologists or political scientists to observe.

Instead, authority is divided among diverse and overlapping spheres, sectors, frameworks, viewpoints, and the like. Each lays claim to special insights, to more potent interpretations, to more human or humane belief systems. There exist many small camps, some encompassed by larger camps. In a word, authority is fragmented.

This dispersion of authority provides social science teachers a structural license to hold their own particular insights and belief systems. At least within broad limits, the final authority for the course they teach is theirs. They may display loyalty to the Founding Fathers, or to some contemporary school of thought, to show their students they are not mavericks, or to establish a minimum of credibility. But within these constraints, they are free.

So social scientists are particularly free, to select as they wish, to organize, to translate. Yet as we have found, once they undertake these exercises they can no longer teach as they might like. They are under direct pressure to lecture.

Students' authority to talk in class comes from their broad access to examples. They grant the teacher the privilege of lecturing in his own terms on white-collar crime, but they want to validate his field's constructs with instances from their own experience. His depiction of a university bureaucracy will only be fully acceptable if it fits their own particulars, and if they share out loud some of these particulars with him and with their classmates. If he ignores their experience, and talks only of bureaucracy in ancient Egypt, they may go to sleep. He has denied them access to a familiar social phenomenon.

Two kinds of democracy. The social science classroom resembles a democracy of checks and balances. Authority is divided between teacher and students. Each serves to constrain the other, as they work together on their shared business.

A literature class has a different kind of democracy, a democracy of discovery. The teacher leads the expedition across a protean, ever-changing terrain. The group's task is to help each member make sense of that terrain. The teacher can provide equipment, a good example, and friendly counsel. But the ultimate discovery belongs to each individual.

The life sciences.

We turn last to the life scientists, who with the physical scientists lectured most: 90% of their classroom meetings were devoted to hour-long lectures.

These teachers take for granted much the same things that physical scientists do; we need not review these assumptions. For many, undergraduate lecturing was an established and unquestioned way of life. In his department, a zoologist said, "it's the only method we know."

Descriptive density. The life sciences deal with plants and animals -- with living things. Description in these disciplines is often a complex matter. To delineate the shape of a head, the workings of a muscle, the ties among plants in an ecological system, or the migration pattern of butterflies, all call for considerable depictive detail, and seldom prove amenable to brief summarization.

Such matters, to be described adequately in talk, can require a good number of words. A zoologist's analysis of the notion of instinct needed sufficient words and phrases to make some orienting generalizations, delineate a cluster of physiological traits, and depict the interactive functioning of these traits in relevant detail.

> I talked about maternal behavior in rats as an example of what everyone considers an "obvious" instinct. I dissected it to show that, as best we understand it now, instinct is nothing more than a collection of physiological variables all functioning relative to one another. For example, what could be more instinctive than the eating behavior of a new-born rat pup? But research shows that this behavior is complexly regulated. For instance, one of the things that affects the whole process of a rat pup's weaning involves eating the mother rat's fecal material. The feces are laden with gut bacteria which inoculate the pup so it can eat solid food.

The depictive detail is also often provided to students in visual illustrations, either drawn on the blackboard, shown with a projector, or circulated as handouts. In a course on marine biology, for example, one zoologist put together a set of illustrated course notes which included summary outlines of his thirty lectures and reproductions of all of the charts, sketches, and diagrams he discussed. On average, he presented and analyzed just over ten illustrations in each 50-minute lecture.

Teaching a life-science class thus typically involved bringing a sizeable mass of material to students. This called for lecturing, one instructor found, simply "because lecturing gives you the ability to transmit a great deal of information." Another professor went further:

> I think biology can only be taught by lecturing. The problem is to present as much material as possible, as quickly as possible, as clearly as possible. The easiest way to do this -- the only way -- is to lecture. One can teach an incredible amount of material by lecturing to students. I don't think any other teaching technique permits you to teach as much.

On the other hand, the pressure to present information in quantity could make classroom hours boring for all present, and could cause important structural omissions:

> I would like in all my lectures to have a general introduction and some general conclusions. But I sometimes stay very specific. The material I deal with in biology is highly specific, and I don't see any way around that. But a lecture that is simply a presentation of rather minute details is less interesting for the lecturer as well as for the students listening.

More often, professors saw the teaching of complicated information as a challenge, and took pride in their success at it. A botanist said:

> I enjoy putting together a package which includes as much information as one can effectively present in a given amount of time, and doing it clearly and effectively. When I am well prepared, I can fit in a lot.

Thus a principal response of life-science teachers to their fields' distinctively dense and detailed disciplinary information was to reproduce parts of it in dense and detailed lectures.

The three operations. Like their counterparts in other fields, these teachers had to select, to organize, and to translate. While all fields reported a steady flow of new research, the flow that life scientists described seemed especially copious. With obvious pride, a number felt obliged to share this new wealth with their undergraduate students: "On several occasions," one biologist said, "it has been exciting to introduce these new bits into my lecture notes, so the students can be kept right up to date on the latest developments." Such introductions, another instructor made clear, need prior screening:

> Some of the new information is too esoteric, or too specific, for the students. But occasionally something comes out that's really exciting, really interesting, and you want to make sure to work it in. In one lecture or another, I'll point out that some good work is going on -- that this theory has been challenged or that point addressed.

And of course no textbook could possibly keep up. One professor said that if he himself wrote a perfect text for his course, "and covered all the materials I feel the students should know today, it would be out of date by the time it was in print." Unlike the physical scientists, who often found textbooks helpful, if of course imperfect, most life scientists we interviewed declared them largely useless.

Again as with other disciplines, these teachers' conceptions of the right level for their lectures could be at odds with students'. A biologist had to contend with popularizations in the mass media:

> I find present-day students so accustomed to TV they tend to believe that knowledge is not valid unless it has been coated with media gloss. I struggle a lot to make them see that the thing itself is exciting, without having first been "processed."

Clearly, media gloss blurred the real outlines of the "thing itself," and so diminished the excitement a sound lecture presentation would be sure to generate.

The organization of disciplinary material into suitable form for the classroom, when it involved the incorporation of recent developments, could call for special skills: "I am quite good at wading through a mass of new information and putting it into some kind of organized structure that a student can master -- at organizing new material into a logical sequence that will help me and others understand biological phenomena." And a two-stage winnowing may precede the presentation of new results to undergraduates:

> I am in the process today of preparing a lecture for an advanced graduate course on the molecular organization of chromosomes and genomes. I have been reading original literature for about six weeks, and I have gradually incorporated it into a new model, in my own mind, for the lecture to my graduate group. Next spring I will simplify it and condense it to constitute a lecture I will give to a sophomore class.

Admissible voices. In the life sciences, the disciplinary attributes which affect classroom proceedings act in concert to make the teacher the sole source of knowledgeable talk, and none legitimate a separate voice for students. A biologist put it bluntly:

> I teach biology, and biology is a subject in which I think there is no point discussing the facts with the students. You know the facts, and the students don't. The students are expected to learn from you.

Another biologist explained further:

> Lecturing gives the instructor the ability to transmit a great deal of information, especially in the lower-level courses. In biology these courses are essential for picking up the terminology, storing facts, and so on. The students accumulate information. You can't have discussion until the students really learn and store and understand a great deal of information. For instance, most freshmen and sophomores don't understand the principles of ecology. A discussion or seminar type of course would be useless at that level, because the students have no background to call upon.

Indeed, in some cases a teacher encouraged speech from students just to let them display their inadequate knowledge, as in a zoologist's comparative anatomy class:

> Students have covered the human eye in elementary school and high school, and most of them feel they understand it very well. So instead of starting with a formal lecture, I ask questions about how the eye works, the names of structures, and so on. It soon becomes apparent that they don't really understand the eye, and then you can go on to explain things.

None of these three instructors, be it noted, made the unfamiliarity of new material part of their

reason for disallowing discussion. Old or new, the material was all largely unfamiliar, and neither students' personal beliefs, everyday experiences, nor prior education validated talk from them, beyond simple questions and answers. Some life-science teachers, in fact, deemed a good lecture so self-sufficient as to leave students no voice at all. A microbiologist said that "if I accomplish what I want to do as a lecturer, there's not much reason for the students to ask questions."

The central place of lectures. Life-science teachers spoke repeatedly of the lecture's salient place in their courses and of the concomitants of this salience. A biologist put it much as some social scientists did:

> I tell the students that everything important in this course will be covered in the lectures. The examinations will be on the lectures. The textbook is just to clear up misunderstandings.

A few students took the point too literally:

> I show a fair amount of slides, which cover points that I think are important. But some students figure this just isn't worth their time. If you're not saying something, they'll just walk out in the middle of a lecture.

For these students, the teacher's spoken words were all that counted.

Some teachers found alarming the sense of total ascendancy over students their lecturing gave them:

> I tried the overhead projector in an undergraduate course, and I began to dislike it. I'd stand up there and read off the transparency. It was on a roll, so I'd crank it and talk and watch the students' heads. They'd take notes, and when they caught up with me, all their heads would come up. But I had too much control: I could let the heads come up, or crank real fast and keep their heads down. I'd rather just stand there with a piece of chalk and talk and write on the blackboard and look at them.

Another professor, to inhibit his students from taking his words as their only course authority, offered an hour of films every week or two. These showed other biologists at work, corroborating points made in his lectures, to be sure, but also authenticating those points independently.

The scientific spirit. More than in other fields, some life scientists brought a sense of scientific inquiry and neutrality from their professional work to their thinking about the lecture. A zoologist joined other respondents in noting his field's traditional reliance on lecturing: "It's the method we use." But he added a caution, "That's all I can say, it has never been put to the test," and went on:

> I sometimes wonder why we do it, but I'm not willing to make any judgmental remarks. You can seemingly convey a lot of information in lectures to a lot of people, quickly. I say "seemingly," because you don't know what's being absorbed by the students.

Another teacher looked at the exams and reacted with dismay: "Sometimes I get discouraged because I've given them an enormous amount of information, and not very much of it has been forthcoming on exam questions." A third biologist carried on the argument:

> I do not feel that hearing one lecture is sufficient for students to learn some point in a science course. It nearly always needs to be reinforced, with assigned reading and study questions and problems. Experience shows that if I give test questions on material covered only in the lecture and not reinforced with additional material, about half the class will fail to master it.

Be it noted, however, that as with the physical sciences, the reinforcement of lecture instruction would occur outside the classroom. Another professor put a different reinforcement to a pointed test:

> Certain exam questions are covered in the lecture alone, to test the efficiency of specific lectures. We tabulate all exam questions. Varying with the year and the test, 55% to 65% of the specific lecture questions are answered correctly, compared to 80% to 95% of the questions covered in the combination of lecture, laboratory, and programmed instruction.

But just as McKeachie (1963) and others have found in broad reviews of the literature, the results were also mixed in our small sample. A microbiologist offered students the option of "semi-programmed" text materials instead of attendance at the lectures. Those who chose the programs performed acceptably on the exams, but the lecture students did better:

> The programs aren't very practical, because the material is too difficult to update every year. There are changes in the field, and these are handled best in the lectures. The students who go to class do better on exam questions dealing with the new matters.

Overall, nonetheless, those instructors' efforts towards a neutral assessment of the lecture seemed more often than not to yield discomfiting results.

III. A WALL AROUND THE CLASSROOM

Our evidence thus indicates that professors' lecturing to undergraduates is acutely responsive to structural pressures placed on teachers by their disciplines. We now add that, in sharp contrast, it appears completely unresponsive to organizational pressures. Our study obtained numerous measures of organizational variables, describing teachers' institutions and teachers' place in these institutions. But it turned out that none of these attributes was related to the extent of lecturing.

Writers on instruction often assume that colleges and universities resort to extensive lecturing in their classrooms because their economic resources are too limited to permit better but more expensive teaching methods. Indeed, some of the professors interviewed for the study took this line. But our survey data allow a systematic check of this possibility, using an indicator that ought to tap into any clear existing trend. The results offer little sign of such a relationship. When respondents' institutions are divided into quartiles according to the proportion of the total school budget that was devoted to instruction, teachers at schools which invested most heavily in instruction lectured approximately as much as teachers where the investment was light. Among those at schools in the quartile with the highest ratio of instructional outlay to overall outlay, 74% lectured, as compared to 82% in the second quartile, 78% in the third, and 84% in the lowest. Not surprisingly, the interviewed professors who blamed their extensive lecturing on their schools' fiscal pinch tended to be at institutions in the low quartile, where the argument might seem well justified. Professors at schools with better-financed instruction did not refer to a fiscal pinch, but lectured just as much.

Other facets of organizational life that might seem likely correlates of the frequency of lecturing proved not to be. A school's student-teacher ratio could reflect the school's average class size, and class size (in Table 3) was indeed linked to lecturing. But schools above the median in number of students per teacher had no more lecturing (79%) than schools below it (81%). (Quartiles make the same point.) The same was true for a number of other indicators of resources that might in anticipation be associated with the frequency of lecturing -- the size of the library, the number of books in the library per student, the school's total budget, and others. We also collected information, for other purposes, on numerous characteristics for which little or no relationship to lecturing is readily conceivable: the proportion of PhD's on the faculty, the ratio of the undergraduate population to the graduate population, the percentage of students living in dormitories, the proportion of students remaining on campus over the weekend, the number of intercollegiate sports, etc. In these cases, it turned out, the negative expectation proved correct. Of course the possibility remains that institutions of higher education systematically influence the level of lecturing in their undergraduate classrooms in ways not tapped by any of the more than 100 organizational attributes and dimensions our study examined. We doubt it.

In similar vein, though the questionnaire did not elicit detailed information about professors' campus standing and involvements, neither of the two measures we did obtain was associated with lecturing. Full professors lectured at a rate (82%) very little different from that for associate professors (78%) or assistant professors (80%), and tenured professors (80%) proved no different than untenured (80%).

Organizationally speaking, thus, a wall appeared to surround the classroom. No structural dimension of a university, or of its undergraduate liberal-arts branch, penetrated into the classroom in any way that systematically affected the extent of lecturing there. This consistent lack of influence throws into sharp relief the considerable differences recorded earlier between instructors' fields. By our evidence, at least, the amount of lecturing in undergraduate classrooms is determined by the nature of academic disciplines, not by the structure of academic organizations.

MUST INNOVATIONS FAIL?

We would like, in conclusion, to offer a brief point about instructional innovations.

Since the turn of the century, educators dissatisfied with the dominance of lecturing in college classrooms have introduced a series of innovative teaching methods, including most prominently the discussion method, programmed instruction, television, independent study, instruction by computer, and the "Keller method" of self-paced instruction. Most of these methods have survived, and have each found a very small niche in American higher education. But as our interviews clearly suggest, and more systematic findings (Blackburn et al., 1980) confirm, only the discussion method has won and held a real place in the classroom. The rest belongs as before to the lecture.

Our findings suggest two further specifying points about the discussion method's success. First, discussion has not established itself evenly across the undergraduate curriculum. In the four fields we studied, it holds a strong place in the teaching of literature, perhaps sufficiently strong to cause a basic modification of the lecturing it complements, to give the part-hour lecture a certain prominence at the expense of the full-hour lecture. Discussion has found a much smaller, but still significant, niche in the social sciences. It has won essentially no niche at all in either the physical sciences or natural sciences. Second, both of the successes reflect a resonance between the discussion method and major characteristics of instructors' disciplinary bodies of knowledge. The method seems almost exactly tailored to a literature student's direct access to literary works, and to the social-science student's ability to illustrate social-science conceptions through personal

experience. In both cases, quite possibly, the innovative method won a real place in the classroom because it opened up patterned opportunities for stressing those disciplinary facts directly, in the routine process of providing instruction to students.

Sadly, this success was probably only fortuitous. The discussion method, like all of the innovations just listed, was designed to improve students' learning processes, not to facilitate the effective teaching of particular topics. The point seems clear: Even instruction which appears ideally tailored to the teaching-learning process, if it remains poorly suited to the necessities of converting a discipline's substantive raw materials into viable instruction, will seldom find wide acceptance. Quite possibly the established teaching methods, faulted as they may be, continue to stay better tuned to these disciplinary requirements.

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Table 1. The extent of lecturing in four fields.

	Physical Sciences and Mathematics	Life Sciences	Social Sciences	Humanities	Totals
Lectured continuously	9%	10%	7%	2%	7%
	} 89%	} 90%	} 81%	} 61%	} 80%
Lectured with interruptions	80%	80%	74%	59%	73%
Lectured 15-25 minutes	5%	5%	11%	15%	9%
All others	6%	5%	8%	24%	11%
N	(249)	(100)	(298)	(173)	(820)

Table 2. The extent of lecturing in the disciplines.
(%s add horizontally)

	Lectured continuously	Lectured with interruptions	Lectured 15-25 mins.	All Others	N
Physical Sciences and Mathematics.					
		96%			
Chemistry	15%	81%	1%	3%	(72)
		91%			
Geology	10%	81%	3%	6%	(31)
		90%			
Physics	9%	81%	5%	5%	(58)
		81%			
Mathematics	5%	76%	10%	9%	(77)
Life Sciences					
		88%			
Biology	11%	77%	4%	8%	(48)
		83%			
Botany	9%	74%	13%	4%	(23)
		100%			
Zoology	12%	88%	--	--	(17)
Social Sciences					
		92%			
Economics	6%	86%	2%	6%	(52)
		79%			
History	4%	75%	8%	13%	(68)
		72%			
Political Science	11%	61%	15%	13%	(46)
		79%			
Psychology	7%	72%	15%	6%	(72)
		80%			
Sociology	6%	74%	14%	6%	(51)
Humanities					
		81%			
Art History	6%	75%	6%	13%	(16)
		51%			
Literature	1%	50%	19%	30%	(95)
		90%			
Philosophy	2%	88%	5%	5%	(41)

Table 3. Class size and lecturing.

Class size	Lectured	N
14 or less	74%	(113)
15 - 24	74%	(181)
25 - 39	80%	(187)
40 - 69	82%	(146)
70 - 99	87%	(63)
100 - 149	95%	(63)
150 or more	98%	(59)

Table 4. Field related to extent of lecturing in larger and smaller classes.

	Larger Classes (25 or more)		Smaller Classes (24 or less)		Totals	
	Lectured	N	Lectured	N	Lectured	N
Physical Sciences	89%	(175)	91%	(74)	89%	(249)
Life Sciences	92%	(66)	85%	(34)	90%	(100)
Social Sciences	83%	(202)	75%	(96)	81%	(298)
Literature	56%	(45)	46%	(50)	51%	(95)
Totals (All respondents)	84%	(526)	73%	(294)	80%	(820)

Table 5. Within fields, sex by extent of lecturing.

	Men		Women	
	Lectured	N	Lectured	N
Physical & Life Sciences	91%	(327)	74%	(19)
Social Sciences	81%	(263)	74%	(35)
Literature	55%	(76)	32%	(19)
Totals (All respondents)	82%	(730)	67%	(87)